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ASHRAE Position Document on

INDOOR AIR QUALITY

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Executive Summary

ASHRAE published a position paper on indoor air quality (IAQ) in 1989 asserting the importance of IAQ as a public health issue. Since 1989, accrued knowledge allowed updated statements of far greater certainty about health effects, exposures of concern and the broad approach that must be adopted toward IAQ, which were reflected in a new position document that was published in 2001 and reaffirmed in 2005. Once again, advancing knowledge (such as new knowledge on airborne infectious diseases and other microbiological hazards), a greater interest in non-commercial building environments (including residential and transportation environments) and emphasis of other new issues (such as consideration of IAQ in sustainable buildings during a time of predicted global climate change) warrants a significant revision to the position document.

IAQ directly impacts occupant health, comfort and work performance. People in buildings frequently report discomfort and building-related health symptoms, and sometimes develop building-related illnesses. In recent decades, significant and substantial research has been conducted on the nature, extent and causes of these comfort and health effects and scientific studies have determined that these health effects and discomfort are associated with characteristics of buildings, HVAC systems and the indoor environment. In contrast, providing superior IAQ can improve health, work performance and school performance, as well as reduce health care costs, and consequently be a source of substantial economic benefits.

While some see energy efficiency and IAQ as contradictory goals, an integrated design can lead to high performing buildings that are both energy efficient and have good IAQ. Passive design features (i.e. the architectural and envelope aspects) can be optimized before active design strategies (HVAC systems) are designed for thermal conditioning and source control can be implemented as the fundamental approach to reducing contaminant levels inside buildings before exposure control, via ventilation and air cleaning, is designed for IAQ. Furthermore, as the world moves rapidly toward constructing high-performance and sustainable buildings, it should be recognized that sustainable/net zero energy building efforts will fail if they achieve energy targets but cause significant health or comfort problems for occupants or impede occupant performance in ways that inhibit the building from attaining the goals for which it was built.

ASHRAE has a direct interest and concern with IAQ. Designers, builders, and operators of buildings, who constitute much of the ASHRAE membership, have a large influence on and responsibility for IAQ and look to ASHRAE for guidance; thus ASHRAE has a responsibility to advance the IAQ arts and sciences.

ASHRAE's position at the present is that:

- IAQ has important impacts on people's comfort, environmental satisfaction, health and work performance, and is thereby central to ASHRAE's purpose.
- The health and economic benefits attainable from improved IAQ are uncertain in magnitude but substantial from a national economic perspective and from the perspective of an individual building owner, operator or occupant.
- IAQ and building energy performance are substantially linked and these linkages must be considered starting at the very earliest stages and throughout the processes of building design, retrofit, and renovation.

- It is critical to maintain acceptable IAQ as significant changes are made to building design and operation to dramatically reduce energy consumption in response to the threat of global climate change.

ASHRAE is committed to:

- maintaining and updating ventilation and IAQ standards and guidelines that strike a balance among IAQ, energy, and first and operational costs
- maintaining up to date ventilation and IAQ information in its Handbook
- supporting ventilation and IAQ research and professional education
- fostering partnerships with key domestic and international organizations to fulfill its commitments.

Further, ASHRAE recommends:

- Policy development in the following areas is recommended as a high priority:
    - U.S. national and state governments should support the adoption into codes of ASHRAE's ventilation and IAQ standards.
    - The U.S. government should establish health-based contaminant concentration limits for commonly occurring chemicals for general population in non-industrial environments.
- Sustainable (green) building performance codes, programs and standards should be based on thorough consideration of the many parameters impacting IAQ to ensure that limited resources are used effectively and IAQ is not compromised for other goals.
- ASHRAE should continue to strive to have its IAQ-related standards implemented in national and local building codes.
- ASHRAE ventilation and IAQ standards and related documents should consider climates outside North America in setting their requirements.
- The following education and training efforts are recommended as high priorities:
    - ASHRAE must make more effective use of web-based tools for IAQ education as the internet becomes the primary source of information for consumers and others.
    - ASHRAE should keep the "Indoor Air Quality Guide – Best Practices for Design, Construction and Commissioning" updated to reflect newly developing scientific and engineering knowledge.
    - ASHRAE should develop an IAQ design professional certification and should ensure that all of its related certification programs (e.g., High Performance Building) teach awareness of IAQ principles.
    - Educational programs should be developed to teach the importance of IAQ and the fundamentals of achieving good IAQ to non-engineers in the building field.
- ASHRAE should expand support for interdisciplinary ventilation and IAQ research.
- A several fold increase is needed in government and foundation support for IAQ research to address the high priority research agenda described in this document.

1.0 ISSUES

Definition of IAQ

For the purposes of this document, the term indoor air quality (IAQ) represents the indoor air concentrations of pollutants that are known or suspected to affect people's comfort, environmental satisfaction, health, or work or school performance. Although this position document does not address thermal conditions, they are important for IAQ because temperature and humidity can affect pollutant emission rates, the growth of microorganisms on building surfaces, the survival of airborne infectious pathogens, the survival of house dust mites which are a source of allergens, people's perception of the quality of indoor air, prevalence rates of building related health symptoms, and work performance. Other indoor environmental factors such as noise and lighting are also not addressed. Important references for more information on thermal conditions and other indoor environmental factors include ANSI/ASHRAE Standard 55-2007, *Thermal Environmental Conditions for Human Occupancy, "*Indoor Air Quality Guide – Best Practices for Design, Construction and Commissioning," Chapter 9, Thermal Comfort, and Chapter 10, Indoor Environmental Health, of the . *ASHRAE Handbook – Fundamentals*, and ASHRAE Guideline 10, Interactions *Affecting the Achievement of an Acceptable Indoor Environment*.

1.1 Impacts on health, comfort and performance

IAQ directly impacts occupant health, comfort and work performance. Well-established, serious health impacts resulting from poor IAQ include Legionnaires' Disease, lung cancer from radon exposure, airborne infection such as pulmonary tuberculosis (TB) and severe acute respiratory syndrome (SARS) (Li et al., 2007), and carbon monoxide (CO) poisoning. People in buildings frequently report discomfort and building-related health symptoms, and sometimes develop building-related illnesses (Hodgson and Kreiss 1986; Brightman et al 1997; Committee on Health Effects of Indoor Allergens 1993; Committee on Asthma and Indoor Air 2000; EPA 1992; Mendell 1993; Menzies and Bourbeau 1997; DHHS 2005). Excessive dampness or moisture in buildings is associated with a range of problems including mold, dust mites and bacteria; and exposure to damp environments is associated with respiratory problems including asthma attacks (Committee on Damp Indoor Spaces and Health 2004; WHO 2009; Mendell et al. 2011).

In recent decades, significant and substantial research has been conducted on the nature, extent and causes of these comfort and health effects. One of the most common health complaints is the occurrence of building-related symptoms including eye, nose and throat irritation, headaches, fatigue and lethargy, upper respiratory symptoms, and skin irritation and rashes (WHO 1983; Kreiss and Hodgson, 1984; Hodgson and Kreiss 1986; Levin, 1989; Mendell and Smith 1990; Mendell 1993; Bluyssen et al. 1996; Brightman et al. 1997). The term "sick building syndrome" has been used to describe the excess prevalence of this collection of symptoms, without attribution to specific pathogens or illnesses. The term "building-related illness" refers to a different set of diseases including hypersensitivity pneumonitis and Legionnaires' disease, which are attributed to illnesses acquired as a result of exposure to pathogens in a building (Hodgson and Kreiss, 1986). Other health effects associated with the indoor environment include symptoms of allergies and asthma (Hodgson and Kreiss 1986; Committee on Health Effects of Indoor Allergens 1993; Committee on Asthma and Indoor Air 2000), respiratory illnesses (Fisk and Rosenfeld 1997; Menzies and Bourbeau 1997), and toxic and systemic effects with known causes (Committee on Indoor Pollutants 1981). Recently, the WHO (2010) published Guidelines for Indoor Air Quality: Selected Pollutants, detailing the health risks of exposures to a short list of common chemicals in indoor air (i.e., benzene, CO, formaldehyde, naphthalene, nitrogen dioxide, polycyclic aromatic hydrocarbons, radon, trichloroethylene and

tetrachloroethylene). These and other chemicals have indoor sources and are often found indoors at concentrations of concern for health.

Scientific studies have determined that these health effects and discomfort are associated with characteristics of buildings, HVAC systems and the indoor environment (Mendell 1993; Menzies and Bourbeau 1997; Seppanen et al. 1999, Committee on Damp Indoor Spaces and Health 2004). Failure to properly design, install, commission, operate or maintain HVAC systems are possible explanations for the observed association of air conditioning with increased SBS symptoms (Levin 1989; Mendell and Smith 1990; Mendell 1993). Symptom prevalences vary widely among buildings within and among different types of HVAC system (Fisk et al. 1989; Zweers et al. 1992), suggesting that the means of applying HVAC, plus other factors, are determinants of symptoms.

1.2 Economic benefits of good IAQ

Providing superior IAQ can improve health, work performance and school performance, as well as reduce health care costs, and consequently be a source of substantial economic benefits (Fisk and Rosenfeld 1997; Fisk and Seppänen 2007; Mendell et al. 2002; Mudarri and Fisk 2007, Wargocki and Djukanovic 2005, Wargocki et al. 2006). As discussed elsewhere in this position document, IAQ improvement measures that have been solidly linked to improved health and/or performance include better control of indoor temperature or comfort, increases in rates of outdoor air supply and reductions in dampness and mold (Sundell et al. 2011). There is also some evidence that reductions in indoor pollutant sources can improve health and performance (Wargocki et al. 2002) and that increases in ventilation rates reduce absence from school and work (Milton et al. 2000, Shendell et al. 2004). The economic benefits accrue from having more productive workers, lower absentee rates and reduced health care costs (Seppänen and Fisk 2005, Wargocki et al. 2005, 2006). In work places, measures that result in only small improvements in performance or absence will often be cost effective because employee costs far exceed the costs of maintaining good IAQ (Wargocki et al. 2006). Additional economic benefits are possible through avoidance of costly IAQ investigations and remediation measures by designing, constructing, and operating buildings in a manner that prevents serious IAQ problems, such as widespread dampness and mold, from occurring.

1.3 Interactions with energy use

The complex relationship between IAQ and external environmental conditions, coupled with the effects of climate change, necessitates a paradigm shift towards creating buildings that are not only comfortable and healthy for the occupants but are also sustainable. It is generally believed that improved IAQ can only result from increased energy consumption. This may be true under some weather conditions where improved IAQ is the result of increased dilution ventilation, but other strategies exist that can both improve IAQ and reduce energy use (Levin and Teichman 1991; Persily and Emmerich 2010). Improved indoor air quality can also result from source control (such as selecting construction materials, furnishings, and maintenance products with low off-gassing rates and restricting the use of fragranced or scented products by occupants), air cleaning (both particulate and gas phase), increasing ventilation efficiency (such as use of displacement air distribution for cooling), and using outdoor air "economizers" (which, in mild weather conditions, reduce energy usage while increasing ventilation rate). Other strategies can be used to mitigate the energy impact of conditioning ventilation air such as energy recovery (such as enthalpy wheels and run-around coils), demand controlled ventilation (e.g. using carbon dioxide sensors), dynamic reset (e.g. adjusting outdoor air rates based on real-time measurement of supply airflow in variable air volume systems), and using dedicated (decoupled) outdoor air systems (particularly effective in hot and humid climates).

An integrated design approach to IAQ and energy can lead to high performing buildings that are both energy efficient and have good IAQ (ASHRAE 2009). Passive design features (i.e. the architectural and envelope aspects) can be optimized before active design strategies (HVAC systems) are considered for thermal, ventilation and IAQ aspects. Likewise, source control is advocated as the fundamental approach to eliminating or reducing the contaminant levels inside the buildings before exposure control, via ventilation and air cleaning,is designed for IAQ.

1.4 IAQ in High-performance and Sustainable Buildings

A significant development since the previous version of this Position Document is the establishment and proliferation of a variety of green building standards, programs, guidelines, etc. There are many green building efforts that collectively are impacting the provision of IAQ in buildings in two primary ways.

First, green building efforts directly impact the decisions made during design, construction, operation and maintenance of a building through requirements and options that accrue points towards a rating (e.g., the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design program (LEED®) and ANSI/ASHRAE/USGBC/IES Standard 189.1-2009, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings*). All of these programs are well-intentioned, but for the most part are not based on thorough consideration of all the many parameters impacting IAQ to ensure that resources are used effectively.

Second, these efforts have the potential to negatively impact IAQ as an unintended consequence of placing a very high emphasis on saving energy. This potential impact may be of greatest concern in efforts to achieve net zero or very low energy as providing good IAQ may be either taken for granted or even seen as a roadblock to a more important goal. It should be recognized that sustainable/net zero energy building efforts will fail if they achieve their energy target but cause significant health or comfort problems for occupants or impede occupant productivity/achievement in ways that inhibit the building from attaining the goals for which it was built.

2.0 BACKGROUND

2.1 Overview

ASHRAE published its first position paper on IAQ in 1989 asserting the importance of IAQ as a public health issue. Since 1989, new knowledge allowed statements of far greater certainty about health effects, exposures of concern, and the broad approach that must be adopted toward IAQ. These updated conclusions were reflected in a new position document that was published in 2001 and reaffirmed in 2005. Once again, advancing knowledge (such as new knowledge on airborne infectious diseases and other microbiological hazards), a greater interest in non-commercial building environments (including residential and transportation), and emphasis of other new issues (such as IAQ in sustainable buildings during a time of predicted global climate change) warrants this revision to the position document.

Previous versions of this position document went into great technical detail on a broad range of IAQ issues. However, that information is today sufficiently covered in other ASHRAE publications such as the Handbook – Fundamentals (particularly Chapters 9 through 12) and "Indoor Air Quality Guide – Best Practices for Design, Construction and Commissioning" and thus will not be included here. Additionally, many specific IAQ issues are not covered here as there are separate Position Documents that cover specific topics including: Airborne Infectious Diseases, Environmental Tobacco Smoke,

Legionellosis and Indoor Mold. Instead, this document focuses on recommendations in several broad areas including policy, research and education related to IAQ.

2.2 ASHRAE's Role

ASHRAE's mission is to advance the arts and sciences of heating, ventilating, air conditioning and refrigerating to serve humanity and promote a sustainable world. HVAC is critical to maintaining acceptable IAQ in nearly all occupied spaces. The primary intent of HVAC is to provide for occupant comfort and health.

ASHRAE fulfills its mission through research, standards writing, publishing and continuing education. Since 1989 when ASHRAE first published a position paper on the importance of IAQ as a public health issue, ASHRAE has conducted research to advance fundamental IAQ knowledge, published documents and provided educational opportunities to spread that knowledge and written standards and related documents to provide the path for that knowledge to be applied in buildings. ASHRAE's role in IAQ is to continue to be the leader in all of these activities within the context of a world shifting rapidly to sustainable design principles.

2.3 Policy (Including Standards and Codes)

ASHRAE has developed and continues to maintain several standards and guidelines related to indoor air quality. These standards form the foundation of IAQ design requirements in much of the US. The following are the most well known and commonly referenced:

- ANSI/ASHRAE Standard 62.1, *Ventilation for Acceptable Indoor Air Quali*ty. This Standard, first published in 1973, establishes ventilation and other IAQ related requirements for buildings other than low rise residential buildings and health care facilities. Its outdoor air ventilation rate requirements have been adopted into the International Mechanical Code and Uniform Mechanical Code, the two most common model building codes in the US. The Standard is also referenced by most green building programs including LEED.
- ANSI/ASHRAE Standard 62.2, *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*. This Standard, first published in 2003, covers low rise residential buildings. Ventilation requirements from this standard have also been adopted into codes, including California's Title 24, and into LEED for Homes and the U.S. Environmental Protection Agency's (EPA) Indoor airPlus program.
- ANSI/ASHRAE/ASHE Standard 170, *Ventilation of Health Care Facilities*. Standard 170 brought together several ventilation standards used throughout North America into a single document. It is now referenced almost exclusively in building codes for ventilation requirements in hospitals and other health care facilities.
- ANSI/ASHRAE Standard 52.2, *Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size*. This Standard is used to measure and rate the performance of particle filters.
- ANSI/ASHRAE/USGBC/IES Standard 189.1, *Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings*. Developed in conjunction with USBGC and Illuminating Engineering Society (IES), this Standard provides rigorous indoor air quality related requirements in sustainable buildings. The Standard was developed so it could be adopted as part of voluntary green/sustainable rating systems, green building incentive programs and ordinances.

Standards 62.1, 62.2, 170 and 189.1 are under continuous maintenance with updates scheduled to be published for approximately every three years to coincide with the revision of model building codes.

Other ASHRAE standards and guidelines related to indoor air quality include the following (the letter "P" after the number indicates "proposed" – not yet published):

- ASHRAE Guideline 10, *Interactions Affecting the Achievement of an Acceptable Indoor Environment*. Developed to highlight important interactions of design/operational relevance among indoor environmental factors including air quality, thermal conditions, lighting and noise.
- ASHRAE Guideline 24, *Ventilation and Indoor Air Quality in Low-Rise Residential Buildings*
- ASHRAE Guideline 26, *Guideline for Field Testing of General Ventilation Filtration Devices and Systems for Removal Efficiency In-Situ by Particle Size and Resistance to Airflow*
- ASHRAE Standard 145.1, *Laboratory Test Method for Assessing the Performance of Gas-Phase Air Cleaning Systems: Loose Granular Media*
- ANSI/ASHRE Standard 160, *Criteria for Moisture Design Analysis in Buildings*
- ANSI/ASHRAE Standard 161, *Air Quality Within Commercial Aircraft*
- ASHRAE Guideline 28P, *Air Quality Within Commercial Aircraft*
- ASHRAE Standard 145.2P, *Laboratory Test Method for Assessing the Performance of Gas-Phase Air Cleaning Systems: Air Cleaning Devices*
- ASHRAE Standard 185.1P, *Method of Testing UVC Lights for Use in Air Handling Units or Air Ducts to Inactivate Airborne Microorganisms*
- ASHRAE Standard 185.2P, *Method of Testing Ultraviolet Lamps for Use in HVAC&R Units or Air Ducts to Inactivate Microorganisms on Irradiated Surfaces*
- ASHRAE Standard 189.2P, *Design, Construction and Operation of Sustainable High Performance Health Care Facilities*

2.4 Education

Direction 2 of the ASHRAE Strategic Plan commits ASHRAE to "be a world-class provider of education and certification programs." While the focus of many of ASHRAE's educational efforts is energy efficiency, clearly this goal needs to include education on the subject of IAQ. Education and other outreach activities in various forms and at various levels are crucial to ensure sustained understanding and appreciation of IAQ issues; technological innovation and development of sustainable IAQ solutions; and industry-wide adoption and implementation of IAQ best practices. ASHRAE's must continue its core educational activities including continued development of the Handbook of Fundamentals, presentation of the latest research information through conferences and related publications, webcasts on significant IAQ topics, and Professional Development Seminars. One area in which significant improvement can be made is in online information, as both the professional and public worlds often look first to the internet when seeking knowledge on any topic. ASHRAE should take steps to ensure that its leading knowledge on IAQ can be found and accessed quickly, rather than people finding and acting on information from less reliable sources.

2.5 Research Needs

There are three primary motivations for research on IAQ. First, there are many gaps about IAQ that need to be filled to provide practical guidance. One example is the almost complete lack of data relating ventilation rates in homes with the health of the occupants, making it impossible to establish scientifically-robust minimum ventilation rate standards for homes. Second, IAQ research is needed to understand how IAQ impacts people's comfort, health and work performance, which makes IAQ important from human well-being and economic perspectives. Third, IAQ is strongly coupled to building energy performance. Buildings consume approximately 40% of all energy used in the U. S., thus, building energy consumption has major implications for climate change, energy security, and national and world economic performance. Without research, IAQ issues could become an increasing

strong barrier to increasing building energy efficiency. With suitable research, IAQ-related health and performance improvements could help to stimulate building energy efficiency.

At present, a number of governmental agencies in the U.S. perform or support modest programs of IAQ research. In the U.S., EPA, U.S. Department of Energy (DOE), U.S. Department of Housing and Urban Development (HUD), National Institute for Occupational Safety and Health (NIOSH), U.S. National Institute of Standards and Technology (NIST) and some state agencies support mostly applied IAQ research, focusing on issues relevant to their mission, but in all cases IAQ is not a central agency focus. The National Institutes of Health (NIH) has supported substantial research on how IAQ factors affect the risks of asthma, but has not supported a broad portfolio of IAQ research. Applied research questions, such as the previous example of residential ventilation rates, have not been a part of their research portfolio. ASHRAE has supported applied IAQ research for many years; however, ASHRAE resources are only sufficient for modest size efforts. Also, ASHRAE is not well positioned to support and manage the more basic and health-oriented aspects of IAQ research. Recently, a few other professional organizations have made small amounts of funding available for IAQ research. Industry supports research on IAQ product development, but has less incentive to support IAQ research unrelated to the development of marketable products. In summary, in the U.S., the combination of governmental, professional, and industry support for IAQ research leaves many large gaps. The situation is similar in many other countries.

The definition of a specific priority research agenda is outside the scope of this position document; however, general recommendations are provided subsequently. These recommendations were developed considering ASHRAE's mission, the status of current research programs, knowledge gaps, and existing documents (ASHRAE 2009; EPA 2001; Committee on the Assessment of Asthma and Indoor Air 2000; Committee on Damp Indoor Spaces and Health 2004; USGBC 2008; Fisk 2009; NSTC 2008) with information on priority IAQ research needs relevant to ASHRAE.

2.6 International perspective

Much of ASHRAE's past research and standards development in IAQ has been North American-centric. However, Direction 4 of the ASHRAE Strategic Plan commits ASHRAE to be "a global leader in the HVAC&R community." While fundamental science doesn't change with geography, many of the conditions that engineers need to consider do, including climate, resource availability, cultural expectations, and building practices. To accomplish this strategic direction, ASHRAE needs to consider global conditions in conducting research, developing standards, and providing education.

ASHRAE Standards 62.1 and 62.2 and other publications in the domain of ventilation and IAQ, such as Indoor Air Quality Guide – Best Practices for Design, Construction and Commissioning, the "ASHRAE Guide for Buildings in Hot and Humid Climates" and several others, are continuously referred to as relevant and useful sources of information in the development of local standards and guidelines in countries around the world. ISO 16814-2008 is an international standard that refers to ASHRAE Standards 62.1 and 62.2 and is intended to specify methods to express the quality of indoor air suitable for human occupancy, to allow several acceptable target levels of indoor air quality, depending on local requirements, constraints and expectations. Although there are significant differences compared to Standards 62.1 and 62.2, a key European Standard, EN15251 also makes reference to them. EN15251 specifies the indoor environmental parameters that have an impact on the energy performance of buildings. It forms part of a series of standards aimed at European harmonization of the methodology for the calculation of the energy performance of buildings under the Energy Performance of Buildings Directive (EPBD). Singapore Standards, SS553-2009 and SS54-2009 have had a strong influence from ASHRAE Standard 62.1. SS 553-2009 is the Code of practice for

air-conditioning and mechanical ventilation in buildings and SS 554-2009 is the Code of practice for indoor air quality for air-conditioned buildings.

Examples of other international standards/codes/guidelines that reference ASHRAE Standards 62.1 or 62.2 include the following:

- Australian Standard 1668.2-2002 sets out design requirements for natural ventilation systems and mechanical air-handling systems that ventilate enclosures.
- Guidance Notes for the Management of Indoor Air Quality, Hong Kong - 2003 aims to provide comprehensive guidelines for the total management of IAQ.
- Ventilation Requirements for Acceptable Indoor Air Quality, SHASE 2003 addresses the ventilation requirements for both building emissions and occupants.
- Indoor Air Quality Control in Public Use Facilities, etc. Act, South Korea, 2004 - a rare example of a country regulating indoor air quality.

3.0 POSITIONS AND RECOMMENDATIONS

3.1 Positions

ASHRAE holds the following strong positions:

- IAQ has important impacts on people's comfort, environmental satisfaction, health, and work performance, and is thereby central to ASHRAE's purpose.
- The health and economic benefits attainable from improved IAQ are uncertain in magnitude but substantial from a national economic perspective and from the perspective of an individual building owner, operator or occupant.
- IAQ and building energy performance are substantially linked and these linkages must be considered starting at the very earliest stages and throughout the processes of building design, retrofit, and renovation.
- It is critical to maintain acceptable IAQ as significant changes are made to building design and operation to dramatically reduce energy consumption in response to the threat of global climate change.
- Designers, builders and operators of buildings, who constitute much of the ASHRAE membership, have a large influence on and responsibility for IAQ and look to ASHRAE for guidance; thus ASHRAE has a responsibility to advance the IAQ arts and sciences.

3.2 ASHRAE Commitments

ASHRAE will maintain and update ventilation and IAQ standards and guidelines that strike a balance among IAQ, energy, and first and operational costs.

ASHRAE will maintain up to date ventilation and IAQ information in its Handbook.

ASHRAE will continue to support ventilation and IAQ research and professional education.
ASHRAE will continue to foster partnerships with key domestic and international organizations to fulfill its commitments.

3.3 Recommendations

<u>**Policy**</u>

Policy development in the following areas is recommended as a high priority:

- U.S. national and state governments should support the adoption into codes of ASHRAE's ventilation and IAQ standards.

- The U.S. government should establish health-based contaminant concentration limits for commonly occurring chemicals for general population in non-industrial environments.

Sustainable building performance codes, programs and standards should be based on thorough consideration of the many parameters impacting IAQ to ensure that limited resources are used effectively and IAQ is not compromised for other goals.

ASHRAE should continue to strive to have its IAQ-related standards implemented in national and local building codes.

ASHRAE ventilation and IAQ standards and related documents should consider climates outside North America in setting their requirements.

Education

The following education and training efforts are recommended as high priorities:

- ASHRAE must make more effective use of web based tools for IAQ education as the internet becomes the primary source of information for consumers and others.
- ASHRAE should keep the "Indoor Air Quality Guide – Best Practices for Design, Construction and Commissioning" updated to reflect newly developing scientific and engineering knowledge.
- ASHRAE should develop an IAQ design professional certification and should ensure that all of its related certification programs (e.g., High Performance Building) address awareness of IAQ principles.
- Educational programs should be developed to teach the importance of IAQ and the fundamentals of achieving good IAQ to building code officials, inspectors, construction trades, etc.

Research

ASHRAE should expand support for interdisciplinary ventilation and IAQ research.

A several fold increase is needed in government and foundation support for IAQ research to address following high priority research agenda:

- relationships of ventilation rates to people's health and work and school performance
- effects of particle and gaseous filtration system characteristics on people's health
- acceptable indoor air pollutant concentrations for non-industrial work places and homes
- technologies and practices for reducing building moisture problems and associated health effects
- technologies and practices, and their integration into systems, for maintaining acceptable IAQ in very energy efficient, sustainable buildings
- reasons for the apparent increase in risks of health symptoms in buildings with air conditioning
- role of ventilation, filtration, UVGI or other air treatment, temperature and humidity in transmission of communicable respiratory diseases such as influenza and common colds

- an improved technical basis and protocols for developing, labeling, and selecting materials and products with low emission rates of pollutants that are likely to significantly affect people's satisfaction, health, or performance
- an improved scientific underpinning for the IAQ-related elements of green building certification systems
- development of modeling and simulation tools for coordinated and integrated building system design that achieves low energy consumption and high indoor environmental quality

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